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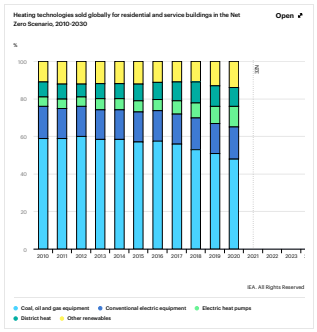
About this report

After years of slow but steady decline, the share of coal, oil and natural gas boilers in global heating equipment sales fell under 50% in 2020. The market is slowly transitioning from a fossil fuel-dominated technology mix towards more efficient or lower-carbo

Nevertheless, in the Net Zero Emissions by 2050 Scenario, the share of heat pumps, low-carbon district heating and renewables-based heating exceeds 80% of sales in 2030.



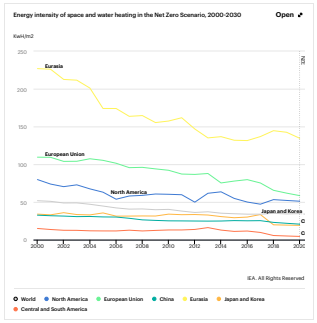
Tracking progress

Energy efficiency progress falls short of necessary savings

Energy use for space and water heating has remained stable since 2010, with heating energy intensities (i.e. final energy use per m^2) decreasing by only 2% per year since 2010 – just enough to offset no more than floor area growth.

Most reductions in heating energy intensity have resulted from stricter building energy codes that have improved the energy performance of new constructions and reduced space heating demand, particularly in Canada, China, the European Union, Russia and the United States.

Meanwhile, shifts to heat pumps, which are typically 3-4 times more efficient than fossil fuel boilers, contributed to the average efficiency of heat provision rising from under 95% in 2010 to 120% in 2020.



Inefficient and fossil fuel-based equipment are finally being phased out

The dominance of fossil fuel-based heaters and water heaters is weakening, with their market share recently having fallen to less than 50%. Despite this positive development, however, new fossil fuel boilers and furnaces still jeopardise the achievement of net zero emissions goals, as they are locking in additional CO_2 emissions that will be released during future operations (boiler manufacturers claim a product lifetime of 15-20 years). The build-up of long-lived, hard-to-retrofit heating equipment must therefore cease as soon as possible, with fossil fuel-based heating solutions completely phased out by 2025 to achieve alignment with the Net Zero Emissions by 2050 Scenario.

The gradual replacement of conventional oil and gas boilers by condensing units (with efficiencies typically 90-95%) over the past decade has reduced boiler emissions by 10%. It is well insufficient to meet the Net Zero target.

Progress towards banning fossil fuel boilers is uneven across regions. Norway, Sweden and Finland have already forbidden oil boiler sales for the past decade, and some US states (e.g. California) and cities (e.g. Seattle) are also making higher-efficiency equipment the new norm by prohibiting the installation of fossil fuel boilers in new buildings. The United Kingdom is likely to follow suit with the release of its Heat and Building Strategy paper, and in many other countries, including, France, Ireland and Austria, oil boilers will be banned in new buildings by 2025 or earlier.

The Net Zero Emissions by 2050 Scenario calls for a drastic shift to clean energy technologies

To be in line with the Net Zero Scenario, the share of clean energy technologies such as heat pumps, solar thermal heating, low-carbon district energy systems and biomass boilers, needs to exceed 80% of new heating equipment sales by 2030.

Alongside building envelope improvements, deployment of these low-carbon high-efficiency heating technologies would help reduce average global heating energy intensity by around 4% annually in the next decade. The combined effects of efficiency improvements, fuel-shifting and power sector decarbonisation would reduce buildings' heating-related emissions by over 50% by 2030.

Heat pumps are the fastest-spreading heating technology in the Net Zero Emissions by 2050 Scenario

180 million heat pumps in heating mode were in operation 2020, up from under 100 million in 2010. However, most of this growth is from higher sales of reversible units that can also provide air conditioning, which reflects rising cooling demand. Overall, heat pumps still meet no more than 7% of global heating needs in buildings. To be in line with the Net Zero Scenario, however, 600 million heat pumps need to provide 20% of global heat demand for buildings by 2030.

Fortunately, the future looks increasingly bright for heat pumps and renewable heating. Sales continued to grow in 2020 in most heating markets, owing to several fiscal and regulatory policies. For instance, through its Clean Winter Heating Programme, China laid out a plan for "2+26" key cities and districts to achieve clean heating services for 90% of demand by 2019 and 100% by 2021. Meanwhile, heat pump sales have continued to accelerate in Europe, where installations jumped by more than 7% in 2020 relative to 2019. On the other side of the Atlantic, British Columbia's low-interest loan for shifting from fossil fuel boilers to heat pumps, California's new building energy code establishing electric heat pumps as the baseline technology, and Massachusetts's minimum performance level requirement for new buildings are all strengthening the heat pump market, particularly for new buildings.

Global total installed solar thermal heat capacity expanded from 230 GW_{th} in 2010 to ~500 GW_{th} in 2020. By comparison, installed solar PV accounts for 710 GW_{elec} and wind capacity for 740 GW_{elec}.

Twenty-two countries, mostly in the Caribbean, the Middle East and sub-Saharan Africa, included using solar energy as part of their sustainable energy actions for heating and cooling in buildings. While 80% of the installed solar thermal systems are used for water heating in single- and multi-family homes, their application is beginning to broaden to industrial and district energy systems.

Another use of solar heat from PVT technology (solar panels coupling PV and thermal heat production) is now emerging, as installed capacity reaches 710 MW_{th} and 230 MW_{elec}, more than half of which is in Europe (including 39% of the global total in France).

Globally, however, solar thermal technology met less than 3% of space and water heating demand in 2020. This falls short of the double-digit average annual growth needed by 2030 under the Net Zero Emissions by 2050 Scenario to meet 5% of buildings sector heat demand. As solar systems are already cost-competitive with very low-level fossil fuel-based heat in many places, awareness-raising and capacity-building will be keys to deployment.

The use of modern and efficient bioenergy for heat in buildings also remains off track, with little uptake of high-efficiency biomass boilers and stoves outside of Europe and North America, where policy support is available.

District energy system decarbonisation and expansion are needed

District heating systems meet less than 10% of heat demand in buildings globally, but this share is much higher in countries such as China (~15%), Russia (~45%) and Denmark (~50%). The number of new connections overall has increased 3.5% per year since 2010, owing particularly to China's extensive network.

Significant effort is still needed to reduce the carbon intensity of district heating, which has remained relatively constant across the globe in recent years. China's reliance on coal makes heat production particularly carbon-intensive, releasing around 350 gCO_2/kWh. Greater policy attention to air pollution in China (e.g. through the recovery of excess industrial heat) promises to reduce the energy and carbon intensity of district heating.

The share of renewable energy sources in European district energy systems increased in recent years, for example in Denmark, Finland, France, Latvia and Lithuania. The carbon intensity of district heat production is typically 150 to ~300 gCO_2/kWh, and decarbonisation efforts currently focus on existing networks and on developing fourth- and fifth-generation low-temperature networks. These highly efficient networks allow for greater integration of renewable energy sources and locally available waste heat.

The solar district heating market is dynamic, and in addition to Denmark, several other countries in Europe and Asia are promoting system development. Synergies with solar power systems are also being explored, including for instance in the UK.

Cities and districts are in a position to lead the energy transition, often setting more ambitious targets than their national counterparts, as district energy networks provide the infrastructure for greater energy security and renewable energy integration.

Hydrogen-based solutions are being explored

Hydrogen is scarcely used in the global buildings sector, although low-carbon hydrogen-based solutions are being tested. A number of challenges, including efficiency losses relative to other low-carbon alternatives, safety considerations, the cost of grid retrofits, and zero-carbon hydrogen production capacity still need to be investigated.

In Japan, the number of ENE-FARM hydrogen-ready fuel cells deployed annually remains steady, with a cumulative 350 000 units installed at the end of March 2021.

In Europe, the ene.field demonstration, launched in 2012, has installed more than 1 000 small stationary fuel-cell systems for residential and commercial buildings in ten countries. Another project is the H21 demonstration in the United Kingdom, which will demonstrate the potential for direct hydrogen use to reduce the carbon intensity of heat demand using steam methane reformers with CCS.

The Sustainable Gas Institute of Imperial College London develops analyses to improve understanding of the role of gas in future low-carbon energy systems. In addition, the UK HyHeat project, which is also evaluating hydrogen potential for heating and covers all stages from appliance certification and quality standards to demonstration, is set to be launched in the second quarter of 2020.

Government-supported hydrogen-blending demonstration projects injecting low-carbon hydrogen into a local gas network are emerging in several cities, including Dunkirk (France) and Adelaide (Australia). The first injections, using a 6% hydrogen blend (by volume), were realised in June 2018, and further blends of up to 20% will be tested, depending on the price of renewable electricity.

Recommended actions

Governments play a key role in setting long-term market signals to direct industry and investor decisions towards sustainable equipment for buildings. On a global scale, fuel-pricing strategies (including taxes and subsidies) need to ensure market equality for all technologies; removing subsidies for fossil fuels is a first step.

In addition, many countries could build upon ongoing efforts to implement CO_2-based taxes. This could be done in Europe through the energy taxation directive, and the EU ETS could be adjusted to cover fossil fuels used in heating systems of less than 20 MW. Germany's scheme in particular covers all heat suppliers and distributers, with a fixed carbon price until 2025 and an auction-based price evaluation post-2025.

Ambitious commitments related to end-use equipment efficiency (e.g. MEPS), emissions (e.g. mandating a share of renewable energy in primary energy use for heat production for buildings) and flexibility (e.g. using smart-readiness labels and incentivising heat storage in water tanks and district energy networks) can take advantage of the synergies gained by using sustainable heating products to achieve multiple climate goals.

Make better use of traditional yet effective policy tools

At the very least, governments everywhere need to implement and update MEPS for heating equipment to steer markets towards clean-energy technologies. These could be technology-neutral (e.g. performance-based) to encourage product innovation and industry competitiveness.

As energy efficiency savings will generate long-term system cost reductions, governments could also promote clean-energy technologies by offering public subsidies for low-income households that may find it difficult to afford them.

For instance, Canada aims for the energy performance of all space heating technologies to be greater than 100%, but it has not specified which technology or fuel should be used to meet this goal.

Countries can also expand and improve labelling schemes for heating equipment (e.g. through energy labels) to increase consumer awareness of energy technology choices. Informational tools could make use of the increasing quantity of building energy data available through digitalisation, as long as the underlying data management frameworks address data privacy and cyber-related issues.

In addition, governments could work together to improve monitoring, verification and enforcement of heating technologies, and collaborate with industry and trade associations to ensure proper equipment installation and maintenance.

As cities are at the heart of the decarbonisation challenge, effective multi-level governance, including vertical integration and horizontal co-operation with various stakeholders, is required to ensure the alignment of local and national policies. District heating and cooling in particular should be an integral part of building renovation strategies in urban environments.

Dare to implement ambitious and innovative policies

Standards and labelling work best when they are part of a wider market transformation strategy. For example, rebates and procurement policies can be employed at different points of the value chain to support energy-efficient technology deployment.

Regulators can also set performance standards or targets that are more stringent than the minimum lifecycle cost (which is common practice) and apply more ambitious requirements, including technology-forcing standards that could stimulate further innovation of clean energy solutions for heating.

To put heating in line with the Net Zero Emissions by 2050 Scenario, policies should set ambitious targets, followed by rigorous performance standards to introduce a larger proportion of high-efficiency low-carbon equipment into the market alongside the phase-out of fossil fuel boilers and furnaces. This is especially important given the long lifespans of many heating technologies (for example, some gas boiler installations are guaranteed for 25 years).

Policies, including innovative business models proposed by energy service companies, need to address the upfront costs of clean, energy-efficient products. Innovative instruments also include guarantees of origin for renewables-based heat as a source of additional revenue for operators.

National and regional accounting rules also strongly influence the attractiveness of energy service delivery models, so allowing companies to record buildings sector assets off their balance sheets could significantly reduce their net debt.

Resources and links

The HPT TCP is a non-profit organisation that aims to accelerate the implementation of heat pump technologies, including for air conditioning and refrigeration, especially when they can reduce energy consumption and increase the use of renewal energy sources for the benefit of the environment.

IEA Heat Pumping Technologies Technology Collaboration Programme

Daniel Mugnier (PVPS TCP), John Dulac (OECD), Caroline H. Stignor (Heat Pump Centre), Monica Axell (Heat Pump Centre), Stephan Renz (HPT TCP), Robin Wiltshire (DHC TCP), Timothy Goodson (IEA), Ariane Millot (IEA), Francois Briens (IEA), Ksenia Petrichenko (IEA), Michael Oppermann (IEA), Yannick Monschauer (IEA), Kevin Lane (IEA).

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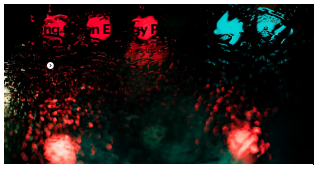

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